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Title	A POSSIBLE CASE OF SITE-CAUSED POLYMORPHISM IN AULACASPIS (HOMOPTERA : COCCOIDEA : DIASPIDIDAE)
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Citation	Insecta matsumurana. Series entomology. New series, 39: 49- 63
Issue Date	1988-09
Doc URL	<a href="http://hdl.handle.net/2115/9844">http://hdl.handle.net/2115/9844</a>
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**A POSSIBLE CASE OF SITE-CAUSED POLYMORPHISM  
IN AULACASPIS (HOMOPTERA : COCCOIDEA : DIASPIDIDAE)**

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Research Trips for Agricultural and Forest Insects in the Subcontinent  
of India, Scientific Report No. 34

*Abstract*

TAKAGI, S. 1988. A possible case of site-caused polymorphism in *Aulacaspis* (Homoptera : Coccoidea : Diaspididae). *Ins. matsum. n. s.* 39 : 49-63, 1 tab., 14 figs. (10 pls.).

Remarkably different forms of *Aulacaspis*, collected in Nepal on the twigs and leaves of *Acer oblongum*, are referred to one species, *Aulacaspis ligulata*, n. sp., and interpreted to represent a case of variation caused by feeding sites.

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In some species of the Diaspididae adult females occurring on the bark and leaves of the host plants are different in the state of the pygidial lobes and other features. Leaf and bark dimorphism is sometimes so remarkable that the ecophenotypic forms were once classified in different species or even different genera. Such cases are known mainly from deciduous trees in the temperate region. Indeed, on deciduous trees the leaf form cannot be persistent unless originated from the bark form every year. In this respect it is surprising that such forms had long been misinterpreted as representing different species.

Much different forms of *Aulacaspis* were collected in Nepal from the evergreen maple *Acer oblongum*. They were found on the twigs and leaves, respectively, of the host at the same locality and even on the same trees. Intermediate individuals, occurring on the leaves, connect them. These forms are regarded as belonging to one species. The variation here involves the numbers of external secretory organs and the development of another feature peculiar to this species.

*Aulacaspis ligulata*, n. sp.

Material. Nepal, on *Acer oblongum* [Aceraceae]. Nagarjun, near Kathmandu, alt. ca. 1400 m (Sept. 6, 1975; Oct. 12 and 15, and Dec. 1, 1983); Godavari, Phulchoki, near Kathmandu, alt. ca. 1700 m (Aug. 19 and 20, 1975); Langtang Valley, alt. ca. 1900 m (Sept. 30, 1975). At Nagarjun adult females were collected from the twigs and leaves of the host, while at Godavari and the Langtang Valley only the twig-form was obtained. A total of about 50 adult females from the twigs and about 60 from the leaves was mounted and examined. Nominiferous specimen [holotype]: adult female, twig-form, Godavari, Aug. 19, 1975 (specimen A in Fig. 1; Figs. 3 & 4), deposited in the collection of the Entomological Institute, Hokkaido University.

Females, when occurring on the twigs, usually make a shallow pit in the bark under the body. Female tests white and nearly round or elliptical, with exuvial casts central; thick when occurring on the twigs. Male tests occurring on the undersurface of the leaves, white, elongate and tricarinate as usual in the genus.

Adult female: twig-form (Figs. 3, 4, 9 & 10). Body robust, constricted in metathorax and abd 1, with prosoma well swollen and abd 2 strongly lobed laterally. Prosoma nearly quadrate with lateral margins almost straight and parallel and anterior margin flatly roundish, and with prosomatic tubercles well developed; sclerotized at maturity, with many small patches on both surfaces. Pygidium broad, nearly straight marginally on each side.

Prosoma with a prominent outgrowth on ventral surface. This outgrowth is curved in a half circle, surrounding the mouthparts and anterior spiracles on their lateral and posterior sides. Numerous dorsal microducts strewn in median region on prosoma, metathorax and abd 1 and 2.

L1s a little sunken into pygidium or almost produced, basally set close or separated from each other by a narrow space, then divergent, broadly round apically. L2 and L3 with both lobules well developed. Marginal gland spines of pygidium slender, 1 laterally to L1 and also to L2, 2-5 laterally to L3 (on abd 6), 1-4 (usually 2) on abd 5, and 4-8 on abd 4. Prepygidial lateral gland spines very short, 7-15 on abd 3, and 3-11 on abd 2. Submedian and submarginal dorsal macroducts numerous, submedian series occurring on abd 3-6 and submarginal series on abd 3-5; these

series are irregularly double or triple, or, in the case of the submedian series on abd 3, fourfold. Submedian macroducts: 15-39 on abd 3, 11-28 on abd 4, 7-16 on abd 5, and 6-16 on abd 6; submarginal macroducts: 7-25 on abd 3, 7-16 on abd 4, and 6-14 on abd 5. Lateral macroducts much smaller than dorsal macroducts, 9-18 on abd 2, and 8-19 on abd 3. Anterior spiracle with 15-31 trilocular disk pores; posterior spiracle with 7-13. Perivulvar disk pores: 11-35 in median group, 15-43 in the anterolateral, and 12-41 in the posterolateral.

Adult female: leaf-form (Figs. 5-8 & 12-14). The specimens mounted from the leaves are rather arbitrarily divided into the leaf-form and intermediate individuals. Leaf-form adult females generally appearing less robust than the twig-form, with prosoma more rounded on anterior margin and less sclerotized and with abd 2 less lobed laterally. Ventral outgrowth of prosoma usually represented by a pair of lines, which may partly be broadened; sometimes obsolete. The state of the outgrowth may be different between the opposite sides of the body. L1s appearing more divergent than in the twig-form, their inner basal margins being separated from each other by a distinct space. Dorsal microducts present or absent, if present much fewer than in the twig-form. Other external secretory organs are also fewer. Gland spines: 1-3 (usually 2) on abd 6 and 5, 3-8 on abd 4, 5-11 on abd 3, and 2-7 on abd 2. Submedian macroducts: 0-6 (usually 0-2) on abd 3, 0-7 (1-2) on abd 4, 1-8 (1-2) on abd 5, and 0-5 (0-2) on abd 6; submarginal macroducts: 0-7 (1-3) on abd 3, 1-7 (2-3) on abd 4, and 1-5 (2) on abd 5. Lateral macroducts: 4-12 on abd 2, and 5-11 on abd 3. Anterior spiracle with 3-ca. 20 disk pores; posterior spiracle with 1-8. Perivulvar disk pores: 8-18 in median group, 8-25 in the anterolateral, and 7-19 in the posterolateral.

Six leaf-associated specimens are lumped as intermediates, coming as a whole between the twig-form and the leaf-form in the numbers of secretory organs (Tab. 1, Fig. 1), the development of the prosomatic outgrowth, and the shape of the median lobes. In the development of the prosomatic outgrowth they show a wide range of variation: the outgrowth may be developed nearly as in the twig-form (specimen D and E in Table 1), rudimentary as usual with the leaf-form (C and F, Fig. 11), or almost obsolete (B and G).

Second instar female (exuvial cast). L1s basally more separated from each other and more divergent in the leaf-form; otherwise no difference between the two forms. Four marginal macroducts occurring on each side, belonging to abd 4-7.

This species is uniquely characterized by the prosomatic outgrowth, which is remarkably developed in the twig-form. It is also well characterized by the median dorsal microducts, which are abundant in the twig-form. *Aulacaspis greeni*, which occurs on *Cinnamomum* in Taiwan, has dorsal microducts on the prosoma and metathorax, but these microducts are submedian in position and few. It definitely differs from the new species in the arrangement of the dorsal macroducts. *Aulacaspis aceris*, associated with "*Acer kawakamii*" [= *A. insulare*, deciduous] in Taiwan, has nothing to do with the new species so far as based on the description.

#### *One species or two ?*

The twig-form and the leaf-form above may represent different species. To which species, then, do the intermediate individuals occurring on the leaves belong ?

They are unlikely to belong to the leaf-species, because they are too much deviated from the great part of the specimens of the leaf-species in the numbers of external secretory organs in spite of their sharing the same feeding site (Tab. 1, Fig. 1). If they are conspecific with the twig-species, they should represent the leaf-form of the species. This supposition is attractive, because the intermediate individuals, more or less approaching the leaf-species, should suggest the origin of the twig-species. It finds, however, a difficulty: the occurrence of the prosomatic outgrowth in the leaf-species.

The prosomatic outgrowth is an unusual feature. It is well developed in the twig-form, and, if it has any function, it must be associated with some aspect of life characteristic of the twig-form. In fact, quite unusually for a member of the genus the twig-form lives in a pit in the bark. The prosomatic outgrowth is usually present in the leaf-form, too, though it is more or less rudimentary. The supposition that the leaf-form represents another species needs an explanation for the rudimentary (and probably non-functional) prosomatic outgrowth. A possible explanation may be that the leaf-species originated from the twig-species, still manifesting the prosomatic outgrowth. Then, if the intermediate individuals belong to the leaf-species, they should be retrospective variations, and if to the twig-species, they should be trials to invade the leaves, which may have preceded the evolution of the leaf-species. Thus the supposition that two species exist requires further suppositions.

Colonizing experiments will give a solution, but no experiment was possible during my trips. At the moment I take the simplest view: all the specimens examined belong to one species, *Aulacaspis ligulata*, which, when occurring on the leaves, fails to fully manifest its characteristic features including the prosomatic outgrowth. In this connection it may be mentioned that the leaf-individuals were collected only at Nagarjun and together with the twig-form. At the other two localities only the twig-form was collected in spite of my inspections of leaves, on which male tests alone were found. This species may primarily occur on the twigs.

Some species of *Aulacaspis* occur on both the bark and the leaves of their host plants, but no remarkable site-caused variation has been reported for them. In fact, bark- and leaf-individuals of *Aulacaspis greeni* are indistinguishable, showing in my examination no significant difference in the numbers of the external secretory organs (the numbers of the dorsal macroducts and the perivulvar disk pores are given as examples in Fig. 2).

In spite of all this the possibility of site-caused polymorphism cannot be excluded for the forms reported in this paper. The case involves a wide variation in the numbers of external secretory organs. Forms of *Aulacaspis* have often been distinguished as different species by the number of the dorsal macroducts. When such forms are associated with the same or related plants and with different sites, the possibility of site-caused variation should be checked.

Table 1. Numbers of external secretory organs in *Aulacaspis ligulata* adult females.

	Leaf-form	Intermediate individuals occurring on leaves						Twig-form
		G	F	E	D	C	B	
Dorsal macroducts	27 - 89 ( $\bar{x}$ =42.1, n=52)	103	122	146	155	161	170	166 - 263 ( $\bar{x}$ =218.9, n=48)
Lateral macroducts	25 - 39 ( $\bar{x}$ =31.7, n=47)	37	36	46	45	45	43	39 - 67 ( $\bar{x}$ =50.8, n=35)
Dorsal microducts								
Prosoma	0    1 - >23 (n=2) (n=48)	>26	57	65	>67	>60	>72	>78 - ca.180 (n=32)
Metathorax	0    5 (n=49) (n=1)	1	1	11	14	8	13	15 - 35 (n=31)
Abd 1	0    2 (n=49) (n=1)	0	0	9	7	2	8	6 - 29 (n=34)
Abd 2	0 (n=50)	0	0	0	2	0	1	0    1 - 25 (n=1) (n=33)
Abd 3	0 (n=50)	0	0	0	0	0	0	0    1    2 (n=30) (n=3) (n=1)
Perivulvar disk pores	52 - 100 ( $\bar{x}$ =70.2, n=52)	106	119	125	123	113	125	86    114 - 182 (n=1) (n=47) ( $\bar{x}$ =145.8)
Spiracular disk pores								
Anterior spiracle	3 - 17    ca.20 ( $\bar{x}$ =8.3, n=100) (n=1)	14 12	15 13	17 13	15 17	14 16	15 13	15 - 31 ( $\bar{x}$ =22.0, n=67)
Posterior spiracle	1 - ca.8 (n=97)	6 8	4 5	8(?) 8(?)	8(?) 7	8(?) 6(?)	7 6	ca.7 - 13 (n=58)
Gland spines	37 - 55 ( $\bar{x}$ =46.6, n=42)	46	51	42	47	48	45	45 - 66 ( $\bar{x}$ =56.0, n=29)

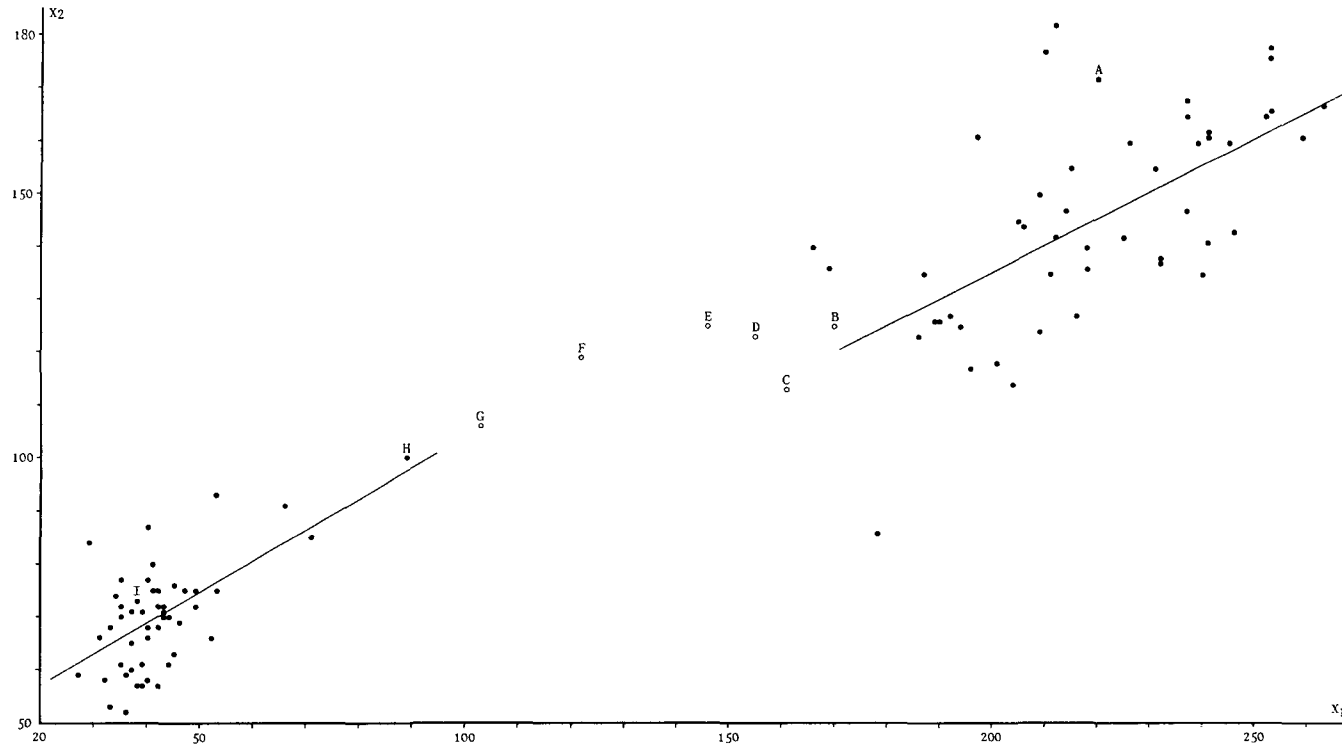


Fig. 1. Total number of perivulvar disk pores ( $X_2$ ) against total number of dorsal macroducts (marginal, submarginal and submedian macroducts) ( $X_1$ ) in *Aulacaspis ligulata*, n. sp.

Group of black circles right : twig-form ;  $X_2 = 0.51 X_1 + 33.39$  ;  $r = 0.628$  ;  $n = 48$ . [A : nominifer ; Figs. 3 & 4.]

Empty circles (B-G) : intermediate individuals occurring on the leaves.

Group of black circles left : leaf-form ;  $X_2 = 0.59 X_1 + 45.23$  ;  $r = 0.612$  ;  $n = 52$ . [H : Figs. 5 & 6 ; I : Figs. 7 & 8.]

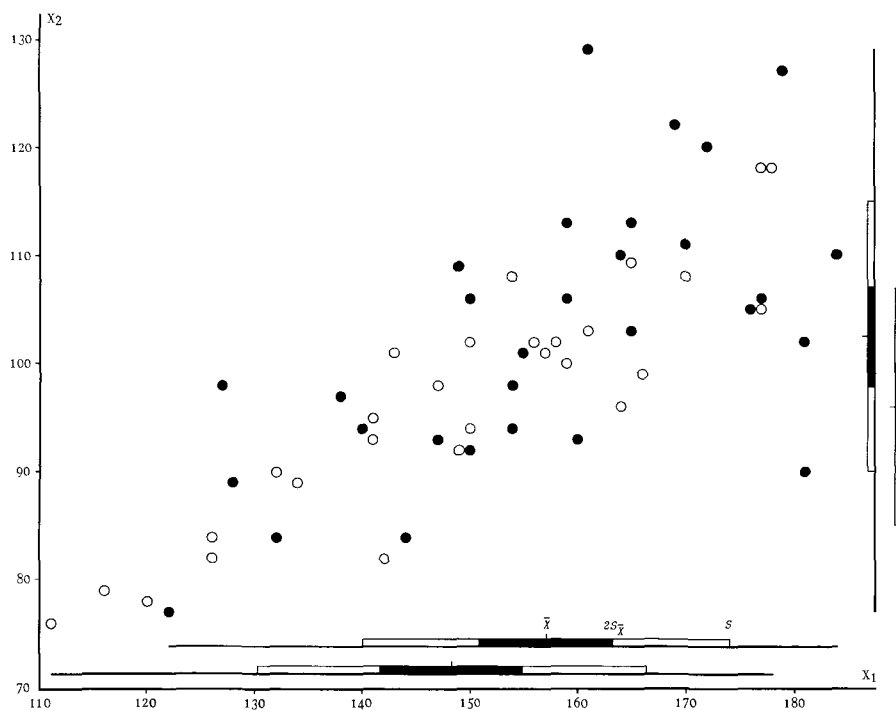


Fig.2. Total number of perivulvar disk pores ( $X_2$ ) against total number of dorsal macroducts (marginal, submarginal and submedian macroducts) ( $X_1$ ) in *Aulacaspis greeni*. Kenting, Taiwan, on *Cinnamomum* sp.  
 Black circles: adult females occurring on the bark ; n=30.  
 Empty circles: adult females occurring on the leaves ; n=30.



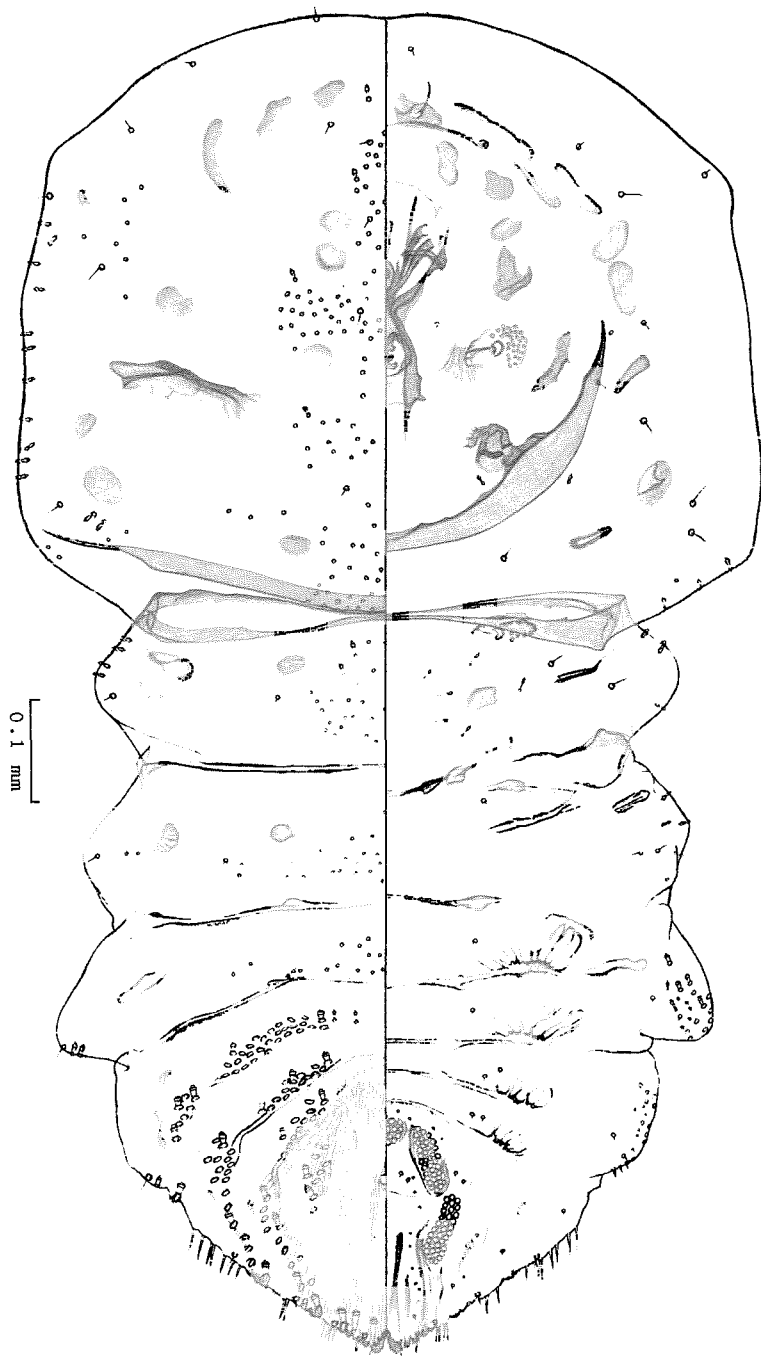


Fig. 3. *Aulacaspis ligulata*, n. sp., adult female, twig-form: body. Godavari. [Drawn from nominifer: specimen A (Fig. 1).]

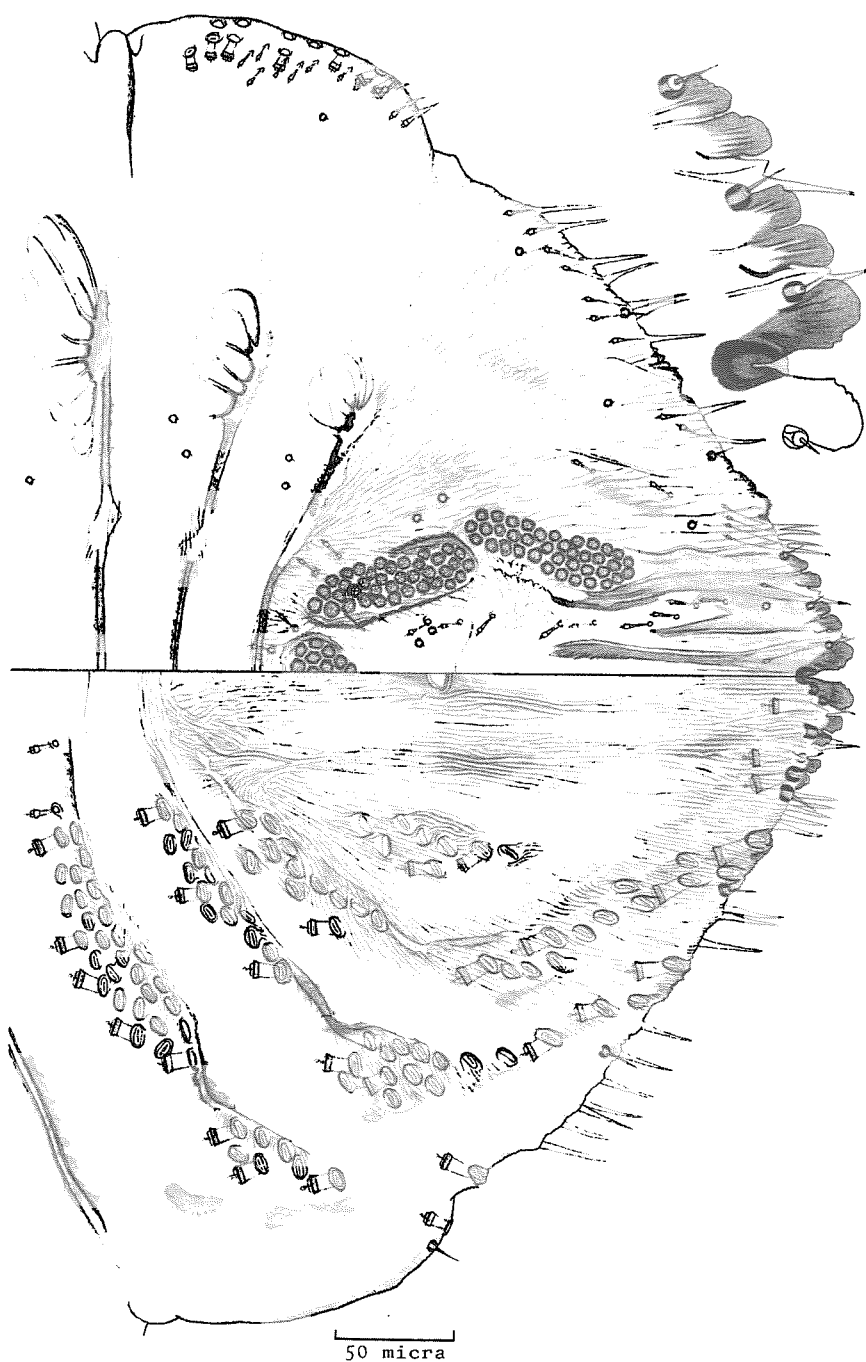


Fig. 4. *Aulacaspis ligulata*, n. sp., adult female, twig-form : pygidium. Godavari. [Drawn from nominifer : specimen A (Fig. 1).]

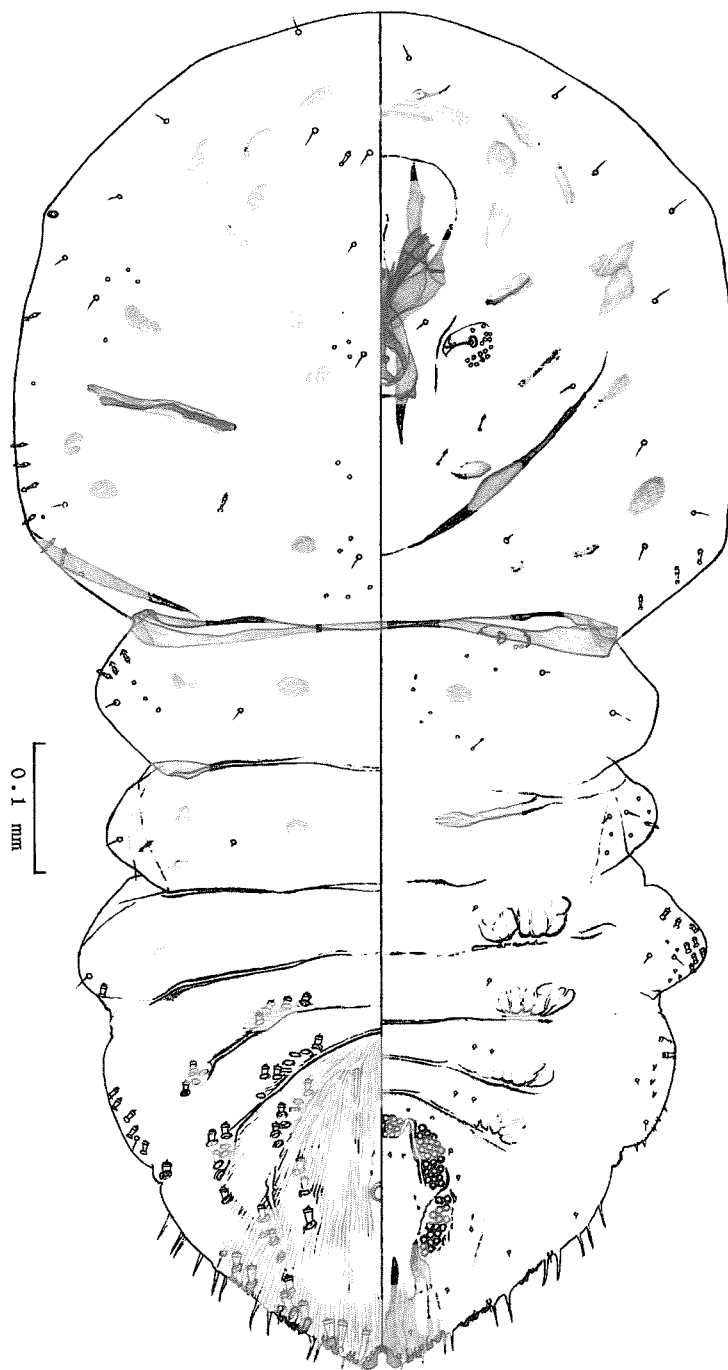


Fig. 5. *Aulacaspis ligulata*, n. sp., adult female, leaf-form: body. [Drawn from specimen H (Fig. 1).]

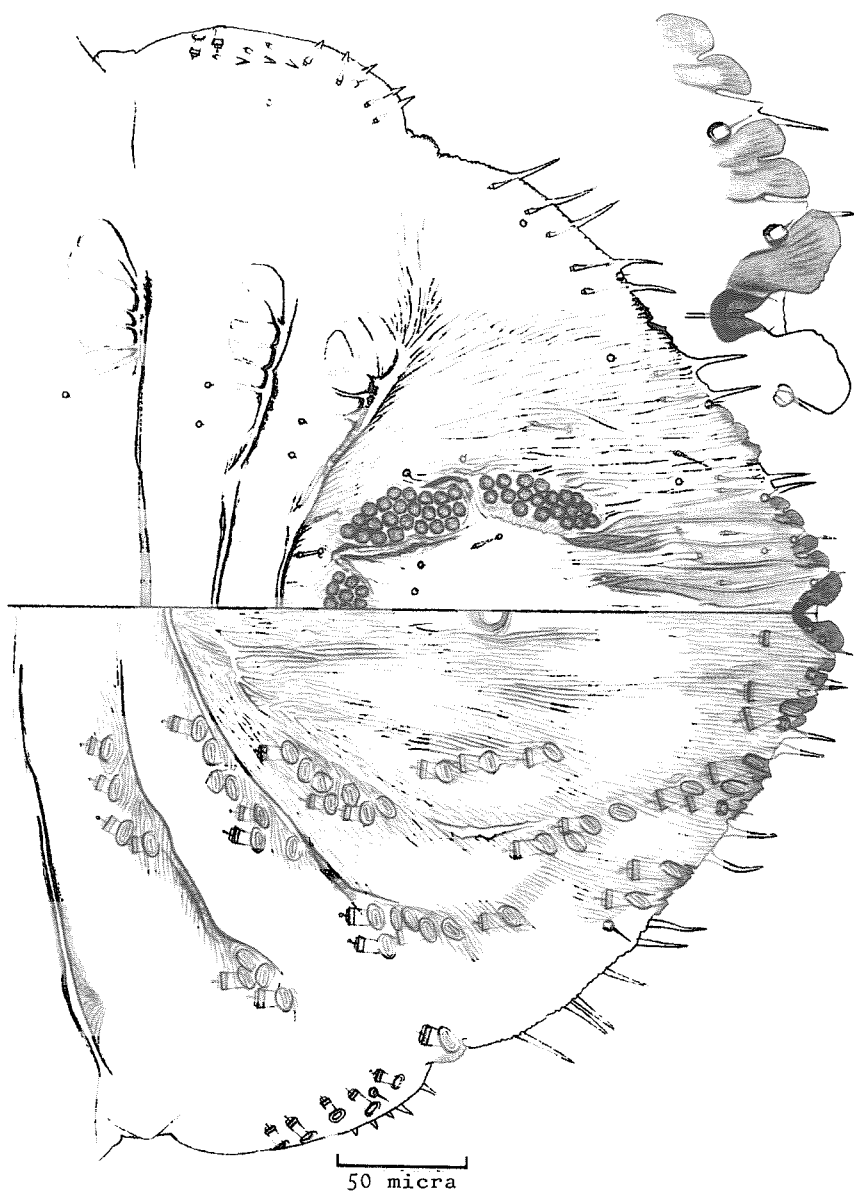


Fig. 6. *Aulacaspis ligulata*, n. sp., adult female, leaf-form : pygidium. [Drawn from specimen H (Fig. 1).]



Fig. 7. *Aulacaspis ligulata*, n. sp., adult female, leaf-form : body. [Drawn from specimen I (Fig. 1).]

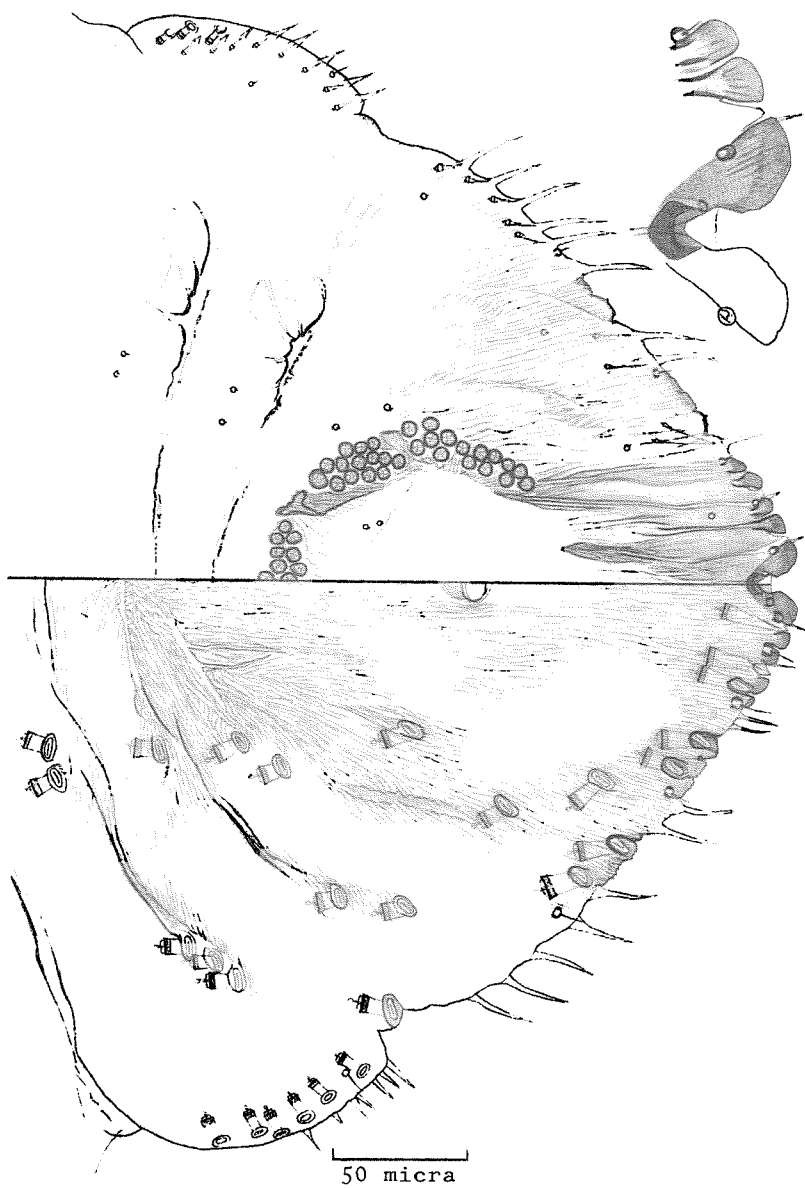
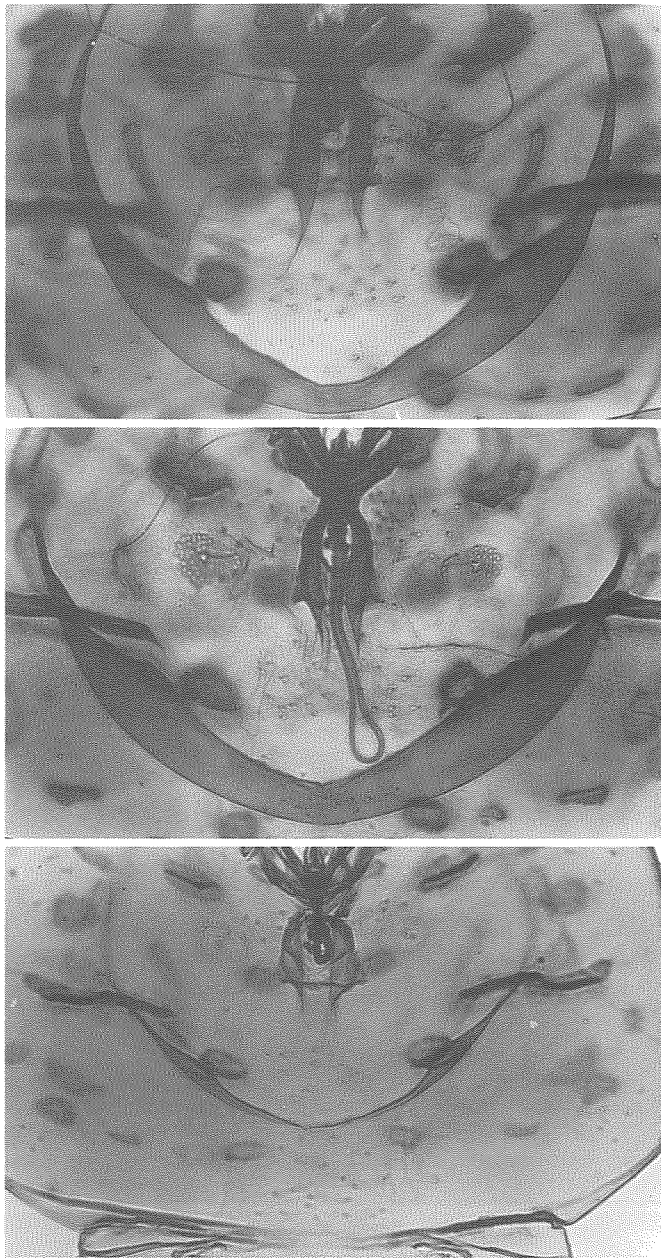
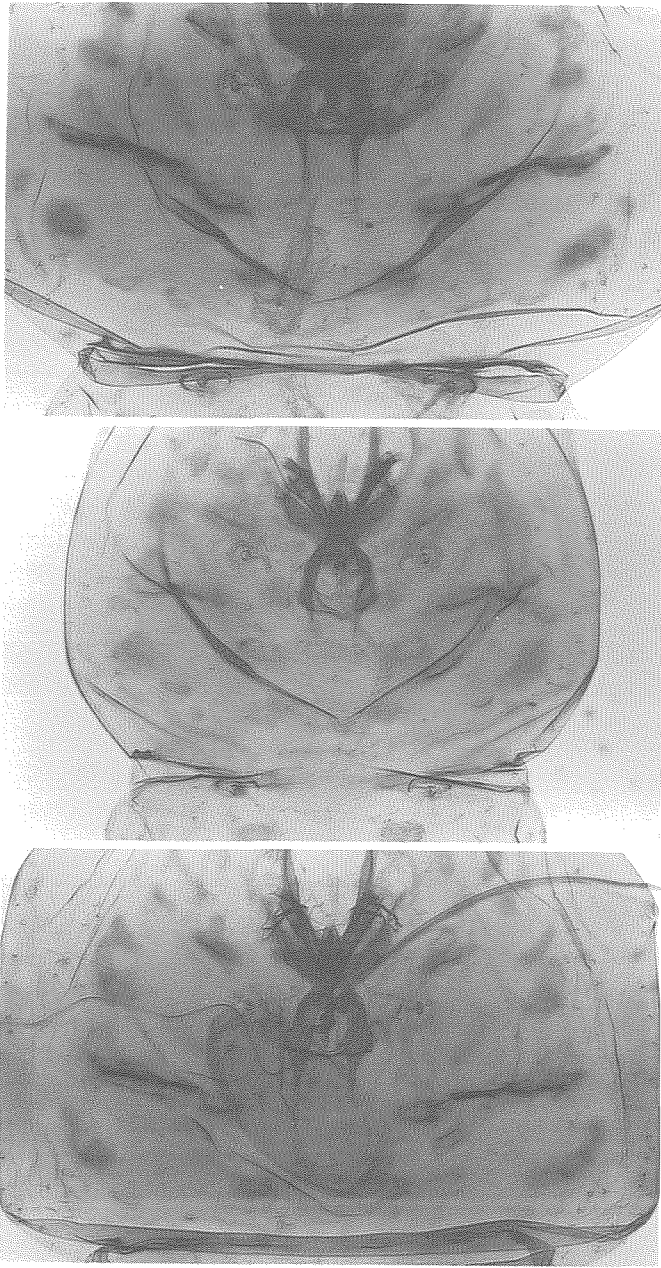


Fig. 8. *Aulacaspis ligulata*, n. sp., adult female, leaf-form : pygidium. [Drawn from specimen I (Fig. 1).]



Figs. 9-11. *Aulacaspis ligulata*, n. sp.; adult female: prosomatic outgrowth. Fig. 9 [upper], twig-form, Nagarjuni. Fig. 10 [middle], twig-form, Godavari. Fig. 11 [lower], intermediate specimen F.



Figs. 12-14 [upper to lower]. *Aulacaspis ligulata*, n. sp.; adult female, leaf-form : prosomatic outgrowth. In Fig. 14 the prosomatic outgrowth is almost obsolete.